

## CLAIMS

What is claimed is:

1 1. A method of determining a movement characteristic of an object, comprising the steps of:

2 a) reflecting electro-magnetic energy off the object;

3 b) receiving the electro-magnetic energy reflected off the object at a sensor; and

4 c) determining a movement characteristic of the object based on the reflected electro-  
5 magnetic energy.

1 2. The method of determining a movement characteristic of an object of claim 1, wherein step

2 c) includes determining one of the speed, direction, distance, location, spin rate, and spin axis  
3 orientation of the object based on the reflected electro-magnetic energy.

1 3. The method of determining a movement characteristic of an object of claim 1, wherein step

2 a) includes:

3 i) aligning the electro-magnetic energy transmission path to be non-parallel  
4 to the movement path of the object; and

5 ii) reflecting electro-magnetic energy off the object.

1 4. The method of determining a movement characteristic of an object of claim 1, wherein step  
2 b) includes:

- 3 i) aligning a sensor's electro-magnetic energy reception path to be non-  
4 parallel to the movement path of the object; and  
5 ii) receiving the electro-magnetic energy reflected off the object at the sensor.

1 5. The method of determining a movement characteristic of an object of claim 3, wherein step  
2 b) includes:

- 3 i) aligning a sensor's electro-magnetic energy reception path to be non-  
4 parallel to the movement path of the object; and  
5 ii) receiving the electro-magnetic energy reflected off the object at the sensor.

1 6. The method of determining a movement characteristic of an object of claim 1, wherein step  
2 c) includes:

- 3 i) determining parameters of a model of the movement of the object based on  
4 the reflected electro-magnetic energy; and  
5 ii) determining a movement characteristic of the object based on the  
6 determined model parameters.

1 7. The method of determining a movement characteristic of an object of claim 6, wherein step  
2 ii) includes determining one of the speed, direction, distance, location, spin rate, and spin axis  
3 orientation of the object based on the reflected electro-magnetic energy.

1 8. The method of determining a movement characteristic of an object of claim 1, wherein the  
2 sensor is one of a Doppler radar sensor and a continuous wave Doppler radar sensor.

1 9. The method of determining a movement characteristic of an object of claim 1, wherein step  
2 b) includes receiving the electro-magnetic energy reflected off the object at two sensors.

1 10. The method of determining a movement characteristic of an object of claim 1, wherein step  
2 b) includes receiving the electro-magnetic energy reflected off the object at three sensors.

1 11. The method of determining a movement characteristic of an object of claim 1, wherein step  
2 a) includes reflecting electro-magnetic energy off a contrasting portion of the object and step  
3 b) includes receiving the electro-magnetic energy reflected off the contrasting portion of the  
4 object at the sensor.

1 12. The method of determining a movement characteristic of an object of claim 11, wherein step  
2 c) includes determining one of the speed, direction, distance, location, spin rate, and spin axis  
3 orientation of the object based on the reflected electro-magnetic energy.

1 13. The method of determining a movement characteristic of an object of claim 11, wherein step  
2 b) includes receiving the electro-magnetic energy reflected off the contrasting portion of the  
3 object at two sensors.

1 14. The method of determining a movement characteristic of an object of claim 11, wherein step  
2 b) includes receiving the electro-magnetic energy reflected off the contrasting portion of the  
3 object at three sensors.

1 15. The method of determining a movement characteristic of an object of claim 11, wherein the  
2 contrasting portion of the object is not discernable at the visible light spectrum.

1 16. The method of determining a movement characteristic of an object of claim 11, wherein the  
2 contrasting portion of the object is highly reflective of the electro-magnetic energy.

1 17. The method of determining a movement characteristic of an object of claim 11, wherein the  
2 contrasting portion of the object is a contrasting marker.

1 18. The method of determining a movement characteristic of an object of claim 17, wherein step  
2 c) includes determining one of the speed, direction, distance, location, spin rate, and spin axis  
3 orientation of the object based on the reflected electro-magnetic energy.

1 19. The method of determining a movement characteristic of an object of claim 17, wherein the  
2 contrasting marker of the object is highly reflective of the electro-magnetic energy.

1 20. The method of determining a movement characteristic of an object of claim 17, wherein the  
2 contrasting marker of the object is not discernable at the visible light spectrum.

1 21. The method of determining a movement characteristic of an object of claim 20, wherein step  
2 c) includes determining one of the speed, direction, distance, location, spin rate, and spin axis  
3 orientation of the object based on the reflected electro-magnetic energy.

1 22. An article of manufacture for use in determining a movement characteristic of an object, the  
2 article of manufacture comprising computer readable storage media including program logic  
3 embedded therein that causes control circuitry to perform the steps of:  
4 a) directing electro-magnetic energy to be reflected off the object;  
5 b) receiving the electro-magnetic energy reflected off the object at a sensor; and  
6 c) determining a movement characteristic of the object based on the reflected electro-  
7 magnetic energy .

1 23. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 22, wherein step c) includes determining one of the speed, direction, distance, location,  
3 spin rate, and spin axis orientation of the object based on the reflected electro-magnetic  
4 energy.

1 24. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 22, wherein step a) includes:  
3 i) directing the electro-magnetic energy transmission path to be non-parallel  
4 to the movement path of the object; and  
5 ii) directing the electro-magnetic energy to be reflected off the object.

1 25. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 22, wherein step b) includes:

- 3 i) directing the electro-magnetic energy reception path to be non-parallel to  
4 the movement path of the object; and
- 5 ii) receiving the electro-magnetic energy reflected off the object at the sensor.

1 26. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 24, wherein step b) includes:

- 3 i) directing the electro-magnetic energy reception path to be non-parallel to  
4 the movement path of the object; and
- 5 ii) receiving the electro-magnetic energy reflected off the object at the sensor.

1 27. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 22, wherein step c) includes:

- 3 i) determining parameters of a model of the movement of the object based on  
4 the reflected electro-magnetic energy; and
- 5 ii) determining a movement characteristic of the object based on the  
6 determined model parameters.

1 28. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 27, wherein step ii) includes determining one of the speed, direction, distance, location,  
3 spin rate, and spin axis orientation of the object based on the reflected electro-magnetic  
4 energy.

1 29. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 22, wherein the sensor is one of a Doppler radar sensor and a continuous wave Doppler  
3 radar sensor.

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1 30. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 22, wherein step b) includes receiving the electro-magnetic energy reflected off the  
3 object at two sensors.

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1 31. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 22, wherein step b) includes receiving the electro-magnetic energy reflected off the  
3 object at three sensors.

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1 32. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 22, wherein step a) includes directing electro-magnetic energy to be reflected off a  
3 contrasting portion of the object and step b) includes receiving the electro-magnetic energy  
4 reflected off the contrasting portion of the object at the sensor.

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1 33. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 32, wherein step c) includes determining one of the speed, direction, distance, location,  
3 spin rate, and spin axis orientation of the object based on the reflected electro-magnetic  
4 energy.

34. The article of manufacture for use in determining a movement characteristic of an object of claim 32, wherein step b) includes receiving the electro-magnetic energy reflected off the contrasting portion of the object at two sensors.

35. The article of manufacture for use in determining a movement characteristic of an object of claim 32, wherein step b) includes receiving the electro-magnetic energy reflected off the contrasting portion of the object at three sensors.

36. The article of manufacture for use in determining a movement characteristic of an object of claim 32, wherein the contrasting portion of the object is not discernable at the visible light spectrum.

37. The article of manufacture for use in determining a movement characteristic of an object of claim 32, wherein the contrasting portion of the object is highly reflective of the electro-magnetic energy.

38. The article of manufacture for use in determining a movement characteristic of an object of claim 32, wherein the contrasting portion of the object is a contrasting marker.

39. The article of manufacture for use in determining a movement characteristic of an object of claim 38, wherein step c) includes determining one of the speed, direction, distance, location, spin rate, and spin axis orientation of the object based on the reflected electro-magnetic energy.



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1 40. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 38, wherein the contrasting marker of the object is highly reflective of the electro-  
3 magnetic energy.

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1 41. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 38, wherein the contrasting marker is not discernable at the visible light spectrum.

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1 42. The article of manufacture for use in determining a movement characteristic of an object of  
2 claim 41, wherein step c) includes determining one of the speed, direction, distance, location,  
3 spin rate, and spin axis orientation of the object based on the reflected electro-magnetic  
4 energy.

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1 43. An apparatus for determining a movement characteristic, comprising:  
2 a) an object having a movement path;  
3 b) an electro-magnetic sensor, the sensor generating electro-magnetic energy to be reflected  
4 off the object and receiving the electro-magnetic energy reflected off the object; and  
5 c) means for determining a movement characteristic of the object based on the reflected  
6 electro-magnetic energy .

1 44. The apparatus for determining a movement characteristic of claim 43, wherein the means for  
2 determining a movement characteristic includes means for determining one of the speed,  
3 direction, distance, location, spin rate, and spin axis orientation of the object based on the  
4 reflected electro-magnetic energy.

1 45. The apparatus for determining a movement characteristic of claim 43, wherein the sensor's  
2 electro-magnetic energy transmission path is non-parallel to the movement path of the object.

1 46. The apparatus for determining a movement characteristic of claim 43, wherein the means for  
2 determining a movement characteristic includes:

- 3 i) means for determining parameters of a model of the movement of the  
4 object based on the reflected electro-magnetic energy; and
- 5 ii) means for determining a movement characteristic of the object based on  
6 the determined model parameters.

1 47. The apparatus for determining a movement characteristic of claim 46, wherein the means for  
2 determining a movement characteristic includes means for determining one of the speed,  
3 direction, distance, location, spin rate, and spin axis orientation of the object based on the  
4 reflected electro-magnetic energy.

1 48. The apparatus for determining a movement characteristic of claim 43, wherein the sensor is  
2 one of a Doppler radar sensor and a continuous wave Doppler radar sensor.

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1 49. The apparatus for determining a movement characteristic of claim 43, further comprising a  
2 second electro-magnetic sensor, the second sensor generating electro-magnetic energy to be  
3 reflected off the object and receiving the electro-magnetic energy reflected off the object.

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1 50. The apparatus for determining a movement characteristic of claim 43, further comprising a  
2 second electro-magnetic sensor, the second sensor generating electro-magnetic energy to be  
3 reflected off the object and receiving the electro-magnetic energy reflected off the object and  
4 a third electro-magnetic sensor, the third sensor generating electro-magnetic energy to be  
5 reflected off the object and receiving the electro-magnetic energy reflected off the object.

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1 51. The apparatus for determining a movement characteristic of an object of claim 43, wherein  
2 the object includes a contrasting portion and the sensor generates electro-magnetic energy to  
3 be reflected off the contrasting portion of the object and receives the electro-magnetic energy  
4 reflected off the contrasting portion of the object.

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1 52. The apparatus for determining a movement characteristic of claim 51, wherein the means for  
2 determining a movement characteristic includes means for determining one of the speed,  
3 direction, distance, location, spin rate, and spin axis orientation of the object based on the  
4 reflected electro-magnetic energy.

1 53. The apparatus for determining a movement characteristic of claim 51, further comprising a  
2 second electro-magnetic sensor, the second sensor generating electro-magnetic energy to be  
3 reflected off the contrasting portion of the object and receiving the electro-magnetic energy  
4 reflected off the contrasting portion of the object.

1 54. The apparatus for determining a movement characteristic of claim 51, further comprising a  
2 second electro-magnetic sensor, the second sensor generating electro-magnetic energy to be  
3 reflected off the contrasting portion of the object and receiving the electro-magnetic energy  
4 reflected off the contrasting portion of the object and a third electro-magnetic sensor, the  
5 third sensor generating electro-magnetic energy to be reflected off the contrasting portion of  
6 the object and receiving the electro-magnetic energy reflected off the contrasting portion of  
7 the object.

1 55. The apparatus for determining the movement characteristic of claim 51, wherein the  
2 contrasting portion of the object is not discernable at the visible light spectrum.

1 56. The apparatus for determining the movement characteristic of claim 51, wherein the  
2 contrasting portion of the object is highly reflective of the electro-magnetic energy.

1 57. The apparatus for determining the movement characteristic of claim 51, wherein the  
2 contrasting portion of the object is a contrasting marker.

1 58. The apparatus for determining a movement characteristic of claim 57, wherein the means for  
2 determining a movement characteristic includes means for determining one of the speed,  
3 direction, distance, location, spin rate, and spin axis orientation of the object based on the  
4 reflected electro-magnetic energy.

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1 59. The apparatus for determining the movement characteristic of claim 57, wherein the  
2 contrasting portion of the object is highly reflective of the electro-magnetic energy.

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1 60. The apparatus for determining the movement characteristic of claim 57, wherein the  
2 contrasting portion of the object is not discernable at the visible light spectrum.

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1 61. The apparatus for determining a movement characteristic of claim 60, wherein the means for  
2 determining a movement characteristic includes means for determining one of the speed,  
3 direction, distance, location, spin rate, and spin axis orientation of the object based on the  
4 reflected electro-magnetic energy.